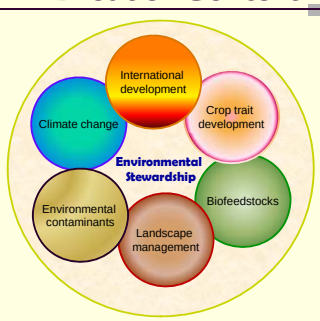
Grand Challenge: Fate & Impact of Chemical & Biological Constituents in the Environment

CSREES Review
February 2-6, 2009

The challenge

Environmental Stewardship in the Broader Context



Department Strength within the Environmental Grand Challenge

- Diverse faculty strengths in basic and applied science at multiple scales (molecular to field)*
- Leadership Positions and Potential
- Diverse instrumentation *(see p. 76 of notebook under Earth System Sciences)*
- Unique and/or easily accessible field sites
- Faculty Camaraderie

Overview of activity – past 5 years

Faculty in the department have been active in

- Investigating the presence, persistence, clean up, and/or behavior of chemicals, nanomaterials, and bacteria in the environment at the lab and field scale.
- Maintaining, enhancing, and launching new environmental educational programs
- Contributing to extension and outreach efforts

Research Activity (past 5 y)

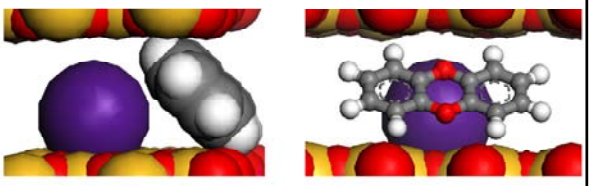
- 11/11 Primary/Secondary Faculty
- Multiple Projects supported by USEPA, NSF, NIEHS, USDA, DOE, DOD (e.g., SERDP), INDOT, NRCS, NASA, Showalter Trust, and several industries (e.g., Animal Ag. Industry, DuPont, Eli Lilly, EPRI, NiSource)
- Center Involvement: Discovery Park Center for the Environment, Birck Nanotechnology Center, Energy Center, & Bindley Bioscience Center; Purdue Climate Change Research Center (PCCRC)
- Collaborating Departments (Primary): ABE, CIVIL, EAS, & FNR and several secondary departments/schools

Primary Research Areas (past 5 y)

- Fate/Behavior in soil and water of both legacy and emerging contaminants (agricultural and industrial)

Clay Mineral Controls on the
Adsorption, Bioavailability, and Long-term Environmental Fate
of Dioxins, PCBs, and PAHs

Purdue (Johnston)-Michigan State University
NIEHS Project



Current & future studies using both computational and experimental methods to assess compound interactions.

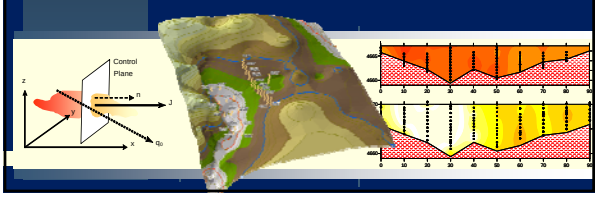
Fate and Impact of Emerging Contaminants at the Lab and Field Scale

Primary Research Areas (past 5 y)

- Fate/Behavior in soil and water of both legacy and emerging contaminants (agricultural and industrial)
- Site Characterization, Remediation, & Reclamation

Flux-Based Site Characterization & Remediation

Suresh Rao
School of Civil Engineering & Agronomy Department
Purdue University



Site Remediation/Reclamation *(Schwab)*

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- Waste Reuse

Site Reclamation & Waste (Biosolids) Reuse
Paul *Schwab*

Site Reclamation & Waste (Fly Ash) Reuse
Linda S. Lee

Primary Research Areas (past 5 y)

- Fate/Behavior in soil and water of both legacy and emerging contaminants (agricultural and industrial)
- Site Characterization, Remediation, & Reclamation
- Waste Reuse
- Bioavailability and Impact *(integrated within the above areas)*
- Air Emission and Transport (Grant)

Education (past 5 y)

- Mentored by Primary Faculty:
  - > 80 M.S. & Ph.D. Students
  - > 20 Post-doctoral Assoc. &Visiting Scientists
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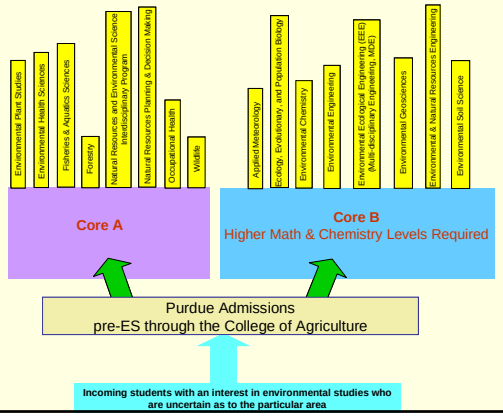
  - Pre-Environmental Studies (pre-ES) Program

A Unique Undergraduate Program

- Administered through the COA, but serves the entire campus
- Pre-ES represents 4 colleges, 9 departments/schools, one interdisciplinary program and one division
- Two Cores differentiated by Math & Chemistry requirements
- 16 programs to enter at the end of their freshman pre-ES core

Launched in 2007

Pre-Environmental Studies Freshman Program



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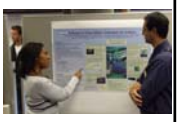
  - Ecological Science & Engineering Interdisciplinary Graduate (ESE-IGP) Program

Ecological Sciences and Engineering Interdisciplinary Graduate Program

Launched in Fall 2005
5 MS graduates; currently enrolled 18 PhD & 8 MS students

- Exposure to the variety of environmental work at Purdue and professional development opportunities
- Curriculum breadth (*Ecology*, *Biogeochemistry*, *Hydrologic Sciences*, *Human Dimensions*, *Ecosystem Tools*, *Life Cycle Analysis*) & unique cohort course provides base needed for effective communication and environmental solutions
- Facilitates sustainability and life cycle thinking
- Enhancing recruitment of top graduate students benefiting diverse departments

Earth Systems Interactions
Green Technology
Human Impacts on Biosphere Processes
Managed Ecosystems
Sustainable Urban Environments



An innovative, campus-wide interdisciplinary graduate program

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  - Environmental Entrepreneurship Idea to Product Competition (EE-I2P)

Environmental Entrepreneurship Idea to Product® (EE-I2P) Competition

Launched in 2006

- Empowering undergraduate & graduate students to develop their ideas into products or services that benefit the environment and society
- Educating on entrepreneurship & intellectual property
- Students from 15 departments, 6 Colleges
- National Competition Opportunities

Solving Grand Challenges in the Environment through Entrepreneurship

2007 Showcased Team
Green Battery Box (AGRY, CIVIL)

2008 1st Place Team
Ubershelter (COT, CIVIL)

2nd Place: Recycled Knowledge
3rd Place: Sustainable Water Pump

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- Natural Resources & Environmental Science Program

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- Natural Resources & Environmental Science Program
- New Courses (collaborative with EAS & CIVIL)*

Outreach (past 5 y)

through….

- Conferences
  - 2004 Midwestern States Risk Assessment (MWSRA) Symposium: PAHs & Metals
  - 2006 MWSRA Symposium: Chlorinated Solvents
  - 2008 Nanotechnology and the Environment Conference

Outreach (past 5 y)

through….

- Web Sites
  - National Livestock and Poultry Environmental Learning Center Pharmaceutical Expert (LPE) Team (http://lpe.unl.edu)
  - CAFOs Animal Sci. Extension http://www.ansc.purdue.edu/CAFO/
  - *Assessment of Nanomaterials in the Environment* (ANE). NSF-EPA funded project website (*www.purdue.ed/ane*)
  - Environmental Pathogens Information Network (EPI-NET) http://www.epi-net.org/enq/

Outreach *(continued)*

through ….

- Webinars
- Popular News Releases
- Commentaries in Professional Magazines

The Next Decade

With the continued rapid growth in technology …

- the number of constituent classes of concern will increase
- concentrations of concern this diverse set of constituents may become increasingly smaller
- the need for more advanced and sensitive instrumentation will increase

…and more efficient and *greener* technologies....

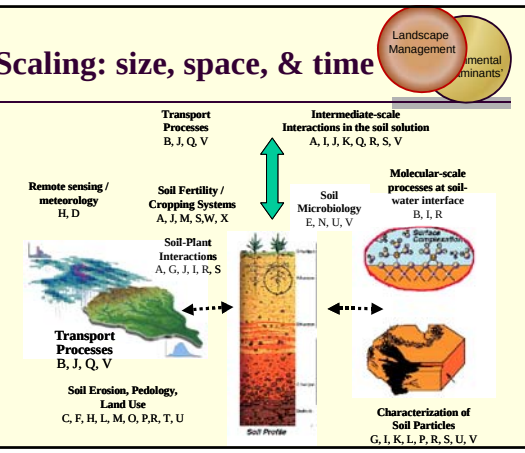
- the more rapid translation of our research towards the development and implementation of sustainable practices and policies will be needed and expected

Fundamental Issues: The Next Decade

To address these challenges…

- **Integration/Synthesis** of knowledge from other disciplines to address strategies
- Research on **Sustainable Practices**
- **Scaling*** - How does existing knowledge translate to understanding and predicting environmental processes emergent at larger scales

Scaling: size, space, & time



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- **Scaling*** - How does existing knowledge translate to understanding and predicting environmental processes emergent at larger scales
- **Linkages** to other disciplines, research teams, and other agencies
- **Decision Tools**

Strategies to Address Fundamental Issues

- Commit to the time and effort needed to
  - Integrate/synthesize our own data sets with others
  - Integrate our knowledge into landscape scale models
  - Integrate our knowledge into existing decision tools and aid in the development of new decision tools and more sustainable practices and policy

Synergy across scales
for increased value
of individual or subgroup efforts
towards a greater impact

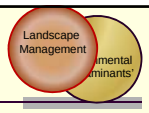
Projects for the Next Decade

- Lab-scale (molecular to soil core) Characterization and Assessment
  - Fate of nanomaterials (representative types) in soil/biosolids and water/wastewater and their impact on aquatic and microbial communities
  - Continued assessment of legacy chemicals: reasons for persistence, their long-term effects, and clean up solutions
  - Fate and effect of legacy chemical replacements: highly fluorinated and brominated in soils, water, wastewater, and biosolids

Projects for the Next Decade

- Field-scale Characterization and Assessment
  - Fate and effect of veterinary pharmaceuticals/hormones in CAFOs and associated agricultural lands
  - Evaluate persistence and leaching of 'emerging contaminants' in biosolid-applied fields
  - Evaluate strategies for optimizing productivity of organic-rich agricultural, industrial, and biosolids
  - Strategies for establishing vegetation at abandoned industrial sites to minimize air and water pollution
  - Optimization of wetlands for mitigation of constituents of concern

Projects for the Next Decade



- Landscape-scale Characterization and Assessment
  - Multi-scale modeling and monitoring of Midwestern landscapes to link atmospheric, hydrologic, pedologic and biogeochemical processes
  - Use of Geographic Information Systems (GIS) to integrate detailed soil survey, digital elevation models, and other data to predict pollutant behavior in the landscape and areas vulnerable to contamination
  - Assimilation and integration of in-situ and remotely sensed measurements of agriculture and non agricultural source air emissions to facilitate assessing 'if – then' scenarios on public health and policy development
  - *Antibiotic-resistant bacteria: fate, development, air transport*

Infrastructure Challenges

- Name recognition
- Funds for equipment maintenance, acquisition, and related staff support.
- Graduate student support relative to the typical length and outcome expectation of federally funded projects.
- *Additional Faculty support in microbial and transport areas*

Strategies to Address Infrastructure Challenges

- Position ourselves to be leaders and active participants in Center-level proposals (e.g., SBRP).
- Generate sustainable plan for equipment maintenance, acquisition (prioritize/target), and related staff support.
- Generate a pool of funds seeded by appropriate industry groups in key areas where applicant pools are or will be deficient in the near future (e.g., environmental and analytical chemistry at the PhD level, water treatment issues at the MS level).
- Increase internal support of fellowship funds to extend to at least 18 months in order to provide faculty-student team a more reasonable length of time to submit a successful proposal.